Cognitive Distortions and Antisocial Behavior among Adults with Traumatic Brain Injury

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ABSTRACT

Every year over 1.7 million people sustain a Traumatic Brain Injury (TBI), making it a leading cause of death and disability in the United States. Research has found that TBI is a risk factor for antisocial behavior and criminal acts. The current research seeks to understand the relationship between TBI and antisocial/criminal behavior. The present study specifically looked at the role of self-serving cognitive distortions (rationalizing or inaccurate thinking patterns) in accounting for antisocial behavior among TBI patients. The methods included administering a cognitive distortion measure (i.e., the How I Think Questionnaire), antisocial behavior self-report questions, and demographic measures to adults with a TBI. This exploratory study of a small (n = 25; 1 participant removed for not filling out the antisocial behavior self-report) sample of male and female TBI patients found a trend linking self-serving cognitive distortions to antisocial behavior. Understanding the use of cognitive distortions among TBI patients may contribute to more effective cognitive behavioral therapies and reductions in judicial and health care costs caused by brain-injured individuals.

Key words: cognitive distortions, antisocial behavior, traumatic brain injury

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Introduction

Public awareness of brain injury has grown exponentially in the past couple of decades. The general population has become more cognizant of the lasting impact that brain injuries, such as concussions, can have on a person. This is in part due to the extensive media-coverage of brain-injury and concussion issues with the National Football League (NFL). Also related to sports, the first baseball player and soccer player known to suffer from Chronic Traumatic Encephalopathy (CTE) – a degenerative brain disease linked to chronic head injury, were diagnosed in 2013 and 2012, respectively. The involvement of the United States in recent wars has also raised general knowledge about brain injuries. Many veterans are coming home having suffered a brain injury – often due to proximity to a blast explosion. In a survey of US armed service members who returned from duty in Afghanistan and Iraq, 19.5% reported experiencing a possible TBI (Corrigan & Cole, 2008).

Although general awareness about brain injuries and their consequences is growing, there is still a deficit in the public's brain-injury knowledge. This has far-reaching effects in terms of the brain-related health policies lawmakers and politicians decide upon, sports rules and regulations relating to head injury that are implemented, and how brain injury is dealt with in our social institutions including schools, nursing homes, health facilities, and prisons.

A Traumatic Brain Injury (TBI) is defined as a nondegenerative, noncongenital insult to the brain caused by an external force, possibly leading to permanent impairment of cognitive and physical functions, and associated with a diminished or altered state of consciousness. Every year over 2.4 million people sustain a TBI – a leading cause of death and disability in the United

States. Annually, an estimated 52,000 die (making up a third of all injury-related deaths in the US), 275,000 are hospitalized, and 1.365 million are treated at an emergency department, while over 5.3 million TBI survivors sustain life-long disability problems (Faul, Xu, Wald, & Coronado, 2010). In 2007, the estimated nationwide incidence of TBI was 101 cases per 100,000 individuals with ages of peak incidence among young adults and people older than 80 years of age (Shiroma, Ferguson, & Pickelsimer, 2010). In terms of gender, males have approximately twice the reported rates of TBI incidence than females (Hirtz, Thurman, Gwinn-Hardy, Mohamed, Chaudhuri, & Zalutsky, 2007). The costs of TBI are extremely distressing for society. The average hospital-based acute rehab costs $8,000 per day, post-acute residential rehab costs $850 to $2,500 per day, and day treatment programs cost $600 to $1,000 per day. The Centers for Disease Control and Prevention estimate that in the United States direct and indirect costs of TBI total around $76.3 billion each year (Faul, Xu, Wald, & Coronado, 2010).

TBI patients evidence a constellation of problems, a notable one being cognitive deficits. This includes slower processing speed, decreased ability to multitask, and shortened cognitive endurance (Corrigan & Cole, 2008). Other research indicates that TBI patients also exhibit changes in memory, attention, concentration, and executive functioning (Miles, Grossman, Johnson, Babb, Diller, & Inglese, 2008). TBI is thought to be associated with cognitive and behavioral problems due to pathophysiological (structural damage caused by the TBI may disinhibit behavior), neurobehavioral (TBI can change how a person views rewards and consequences), and developmental (the earlier in life the TBI, the more predisposed a person is to problem behavior issues) reasons. Cognitive issues may even be more devastating than motor issues as research with brain-injured rats found that cognitive impairments in TBI far exceeded impairments of motor dysfunction (Hamm et al., 1992). Cognitive issues may cause various life

problems including playing a role in employment issues that people face after a TBI. Research has found post-injury unemployment rates as high as 78% for TBI patients (Kreutzer et al., 2003). Cognitive consequences due to TBI may also be a barrier to seeking services or remaining engaged in treatment. Most relevant to this study, strong evidence suggests a link a link between cognition and aggressive (or more broadly, "antisocial") behavior (Sestir & Bartolow, 2007).

Antisocial behavior characterizes disruptive acts that encompass both illegal and legal actions not welcomed by society. The Crime and Disorder Act of 1998 defines antisocial behavior as "acting in a manner that has caused, or was likely to cause, harassment, alarm, or distress to one or more persons." Antisocial behavior adversely affects rehabilitation and treatment outcomes and strains interpersonal relationships (Kreutzer, Marwitz, & Witol, 1995). TBI patients are at high risk for engaging in antisocial behavior, resulting in legal problems and additional harm to others and society (Brower & Price, 2001). Effective treatment programs require an understanding of the processes and mechanisms involved in this constellation of problems prevalent among TBI patients.

One mechanism that may facilitate antisocial behavior among TBI patients is self-serving cognitive distortions (i.e., irrational or inaccurate thinking patterns that may serve to reduce behavior-related guilt or protect self-concept). A general example of a cognitive distortion is when someone rationalizes stealing an accidentally left behind wallet or purse because, "if the owner forgot their property they deserve to have it stolen" (Barriga, Gibbs, Potter, & Liau, 2001). Another example would be when substance-abusing individuals minimize or deny heavy use of alcohol or illicit drugs, associated illegal behavior such as theft to support drug habits, or need for treatment. Persons with a TBI may be especially vulnerable to the use of self-serving cognitive distortions given that their executive functioning, goal-directed behavior, and emotion

regulation are impaired by their injury (Corrigan & Cole, 2008). In a criminogenic sphere, cognitive distortions can lead to antisocial behavior in that they may pervasively neutralize concern for victims (McCrady, Kaufman, Vasey, Barriga, Devlin, & Gibbs, 2008).

Apprehensions that TBI patients are inappropriate candidates for cognitive interventions due to their impaired cognitive abilities, are assuaged by multiple studies that evidence the benefits of cognitive therapies in helping patients adjust to brain injury. Not only does intervention with brain-injured patients possibly benefit them, but researchers and practitioners also benefit from the unique source of information that examining the cognitive deficits of someone with a TBI can provide about how cognitive mechanisms work in the brain (Kinney, 2001). Additionally, cognitive impairments affect all other levels of rehabilitation. Without cognitive participation from the TBI patient it is difficult, if not impossible, to make any rehabilitative progress. By addressing cognitive issues, other areas of rehabilitation (e.g., physical, emotional, etc.) can be improved (Mateer, Sira, & O'Connell, 2005). Investigating the role of cognitive distortions in the problem constellation of TBI individuals may thus contribute to better treatment programs. By improving treatment and rehabilitation for persons who sustain a TBI, health care and prison costs created by brain-injured individuals might be reduced.

Literature Review

Brain injury and cognitive distortions have both been found to be risk factors in antisocial behavior (Sander et al., 2012). Since 1835, case studies have noted the onset of antisocial behavior after brain injury (Brower & Price, 2001). A more recent study examined 15 death row inmates and found all 15 to have vast histories of severe head trauma (Lewis, Pincus, Feldman, Jackson, & Bard, 1986). Although death row inmates represent a particularly violent population, inmates besides those on death row have also been found to suffer from brain injuries. In one

study, over one-third of the participants, who were serving prison sentences at the time, reported sustaining a TBI in *just* the 12 months prior to being interviewed (Slaughter, Fann, & Ehde, 2003). A meta-analysis examining 25 studies that looked at the lifetime prevalence of TBI in an incarcerated sample found that the odds of having a TBI in an incarcerated population is likely significantly higher than in the general population, despite the fact that estimated lifetime prevalence of TBI in the general population can be quite high. The estimated prevalence of TBI in the overall offender population was 60.25% in 2010 (Shiroma, Ferguson, & Pickelsimer, 2010). TBI appears to be associated in some way with incarceration, a consistent finding across peer-reviewed literature in this area of study (Farrer & Hedges, 2011).

The causality between TBI and antisocial behavior or incarceration may be bidirectional. For instance, having a TBI may make a person more likely to be aggressive or incarcerated; in the other direction, an aggressive or incarcerated person being more likely to sustain a TBI. Antisocial and criminal behavior appears to progressively increase after someone sustains a TBI. One study found that within 1 year after sustaining a severe TBI, 7% of participants had legal problems. By 5 years after the TBI, 31% had legal problems (Brooks, Campsie, Symington, Beattie, & McKinlay, 1986). A more recent study found that 24% of TBI survivors studied had committed crimes that led to arrest within 2 years after sustaining the TBI (Hall, Karzmark, Stevens, Englander, O'Hare, & Wright, 1994). A study that reviewed the rate of head injuries for men who had been referred for evaluation of marital violence found that 61% had a history of severe head injury (Rosenbaum & Hoge, 1989). Additionally, aggression has been found to become a chronic problem after sustaining a TBI. 25% of subjects in one study, who had sustained a moderate to severe TBI, had high levels of aggression 5 years after their injury (Baguley, Cooper, & Felmingham, 2006). Brooks et al. (1986) found that 15% of patients, 1-year

after sustaining a TBI, reported threats or demonstrated gestures of violence. At the 5-year mark, this increased to 54%. Furthermore, 10% of these patients had been physically violent with a relative within 1-year after their TBI, with that number increasing to 20% at 5-years post-injury. Alternatively, causality may proceed in the other direction, with aggression or incarceration making a person more likely to sustain a TBI.

Since most of this data comes from self-report studies, there has been concern of a discrepancy between offender-reported TBI and actual TBI. However, Schofield et al. (2011), found that prisoner's reports of TBI held 70% agreement with medically confirmed TBI occurrences. The association of TBI to both antisocial and criminal behavior evidences the fact that more emphasis needs to be placed on both preventing criminal behavior in TBI patients and treating TBI-related symptoms in an incarcerated population.

Not only has antisocial behavior been empirically linked not only to brain injury, but also to cognitive distortions. Research indicates that self-serving cognitive distortions are an important component in facilitating antisocial behavior (Liau, Barriga, & Gibbs, 1998). An integral part of addressing antisocial and criminal behavior in both TBI-afflicted persons and those in the general population is to understand how an offender functions cognitively (Wallinius, Johansson, Lardén, & Dernevik, 2011). A meta-analysis of the literature found that antisocial cognitions, values, and behaviors were the best predictors of adult criminal recidivism (Gendreau, Little, & Goggin, 1996).

In general, those in incarcerated populations display higher levels of self-serving cognitive distortions than non-offenders (Wallinius, Johansson, Lardén, & Dernevik, 2011). More specific incarcerated populations have also been examined. Studies of male and female sex offenders found that both groups had increased scores on cognitive distortion measures

compared to the typical population (Strickland, 2008; McCrady, Kaufman, Vasey, Barriga, Devlin, & Gibbs, 2008). Besides sex offenders, perpetrators of domestic violence have also been empirically shown to engage in cognitive distortions related to their criminal behavior (Gilchrist, 2007).

Aggression, mentioned earlier in relation to brain injury, can induce cognition distortions, which in turn leads to more aggression. For example, aggressive boys interpret the ambiguous behavior of others as hostile and as a result respond to situations using physical aggression, as opposed to more prosocial verbal problem-solving (e.g., a constructive discussion of the problem; Lochman & Dodge, 1994).

Exploratory Aim of the Present Research

In sum, in a number of populations investigated, a functional link has been found between antisocial individuals and their use of self-serving cognitive distortions. This possible link has been under-investigated for TBI populations. Accordingly, the present study investigates whether self-serving cognitive distortions play a role in the antisocial behavior of TBI patients who abuse substances. By administering a cognitive distortion measure and an antisocial behavior self-report scale to adults with a TBI, the relationship of self-serving cognitive distortions to antisocial behavior can be explored.

Methods

The methods of the study included Participants and Setting, Measures, Data Collection Procedure, and Data Analysis.

Participants and Setting

The initial sample size for this research consisted of 26 participants (17 males, 7 females, and 2 not reporting gender) aged 18-61+ (51-55 years being the most commonly chosen age

category). 18 participants were not employed at the time of the study. Of the three questionnaires, 25 participants completed all three and 1 participant completed only the first questionnaire (the HIT). All participants were receiving treatment at the TBI Network, located at Martha Morehouse at Ohio State University's Wexner Medical Center. This program offers services to Franklin County residents who have both a TBI and substance abuse issues. Most TBI Network clients are referred to the program through the criminal justice system or other alcohol and drug treatment providers. Clients may also join the program voluntarily. The average age range for clientele at the TBI Network is 42 to 46 years old (clients must be at least 18 years of age to join the program) and more men than women are served.

Treatment goals for TBI Network patients include establishing substance abstinence and gaining cognitive improvement, but also in many cases attaining employment. Case managers assist clients with various interventions and activities that facilitate obtaining and maintaining their treatment goals. This may include such measures as finding physicians to help clients address cognitive, emotional, or physical concerns, helping clients apply for entitlements, individual counseling, group counseling, referrals to mental health programs, help dealing with housing agencies, and exploring possible job placements with the client. All clients receive group counseling that is based on stage-wise treatment for substance use disorders. Clients are placed in a weekly group counseling session based on their recovery process or lack thereof, and the TBI Network offers a group session for clients who are still currently abusing substances. All clients are also provided with intensive case management and individual counseling.

A client completes the program when they have achieved their treatment goals, which they discuss and determine with their case manager at the beginning of their treatment. 16% of clients complete the program with "goals met" status. "Goals met" status is typically reached in

an average of 21 months. The rest of the clients drop out of the program, become incarcerated, cannot be followed up with, or are unable to meet their goals in a timely manner.

Program clients willing to participate in the current study completed a cognitive distortion measure, an antisocial behavior self-report, and demographic questions (see *Data Collection Procedure*).

Measures

Cognitive Distortion Measure: How I Think Questionnaire

The How I Think (HIT) Questionnaire measures four categories of self-serving cognitive distortions (Gibbs, Barriga, & Potter, 2001). The categories include Self-Centered, Blaming Others, Minimizing/Mislabeling, and Assuming the Worst. Self-Centered has to do with giving credence to one's own views, expectations, needs, rights, immediate feelings, and desires so much so that the legitimate views, etc. of others are barely considered or completely disregarded altogether. Blaming Others is when a person misattributes blame for their own harmful actions to outside sources (especially to another person, group, or externalized state – being drunk, high, in a bad mood, etc.). Minimizing/Mislabeling is the depiction of antisocial behavior as causing no real harm or as an acceptable, sometimes even admirable, action. Assuming the Worst has to do with attributing hostile intentions to others even when the other has no such intentions. For instance, considering a worst-case scenario for a social situation as if it were inevitable, or assuming that improvement in one's own or others' behavior is impossible (Barriga, Landau, Stinson II, Liau, & Gibbs, 2000).

Self-Centered is conceptualized as primary, with the other three categories referred to as secondary in that they may play a protective or supportive role for the primary distortion of self-centeredness (McCrady, Kaufman, Vasey, Barriga, Devlin, & Gibbs, 2008). Items from the

cognitive distortion categories can be applied to four behavioral referent subscales: Opposition-Defiance, Physical Aggression, Lying, and Stealing. Thus, the question on the HIT of "People force me to lie when they ask me too many questions" applies the blaming others cognitive distortion to lying. The HIT also includes an Anomalous Responding (AR) scale that is designed to screen for disingenuous (i.e., social desirability, impression management), incompetent, or otherwise suspect responding (Barriga, Gibbs, Potter, & Liau, 2001).

The HIT requires a fourth-grade reading level and can be completed in less than 15 minutes. Comprised of 54 self-serving cognitive distortion examples, the participant rates how much he/she agrees or disagrees with each statement on a 6-point Likert type scale ("agree strongly" to "disagree strongly") where low scores indicate more cognitive distortions. An example item is: "If someone is careless enough to lose a wallet, they deserve to have it stolen". If the participant agrees with this statement then that demonstrates agreement with a cognitive distortion. The questionnaire contains thirty-nine items stating attitudes or beliefs, eight items controlling for anomalous responses, and seven items as positive fillers. High test-retest reliability for the HIT (r |135| = .91, $p < .0001$ at a 1-week interval) has been previously established (Barriga & Gibbs, 1996).

Although the HIT was designed for adolescent populations, the questionnaire has been successfully used in research with incarcerated adults and has displayed good reliability and validity. According to thorough research of previous studies, this is the first time the HIT has been used with a specific population of TBI patients. Additionally, this is the first time that the HIT has been utilized with online formatting, rather than an in-person proctor (see *Data Collection Procedure*). The online format was used to help protect participant's anonymity so

that they would be more willing to truthfully answer personal questions and questions related to criminal history.

Antisocial Behavior Self-Report

The Antisocial Behavior Self-Report asks questions about participant's actions within the past year. Questions pertained to property destruction, theft, fraud, drug dealing involvement, physical assault and battery, and sexual violence. These self-report questions are not part of any previously established measure.

Demographic Questions

The demographic portion included the following items: age, gender, race/ethnicity, highest completed level of education, marital status, employment status, veteran status, religious preference, and number of times participating in the TBI Network program.

Data Collection Procedure

In the present study, the research software website Qualtrics was used. Participants read an online consent form before completing any of the study. They were told that clicking "continue" after reading about the study was interpreted as consent to participate in the research. By not having participants sign their names on consent forms, data could be more easily kept anonymous. Participants completed the HIT, antisocial behavior self-report questions, and demographic questions in that order. All sections of the study were presented to participants in an online format. For their time, participants were given a gift card to Wal-Mart in the amount of $5.00.

Data Analysis

MATLAB R2014a, a multi-paradigm numerical computing language, was used to code for participants' HIT scores. The SPSS statistical program for Macintosh was used for all other

data analysis. Pearson product correlations evaluated the relationship between scores on all HIT scales and antisocial behavior self-report scores. A Cronbach's alpha was performed to check for internal consistency among the HIT scales.

Results

The main finding of this exploratory study of a TBI population was a trend between self-serving cognitive distortions (measured by the HIT) and self-reported antisocial/criminal behavior. Among the HIT factors, Self-Centered played an especially strong role in this trend. The trend between Self-Centered and antisocial behavior even became statistically significant when the high AR score cases (defined in the HIT Scoring Guidelines as anything above 4.25) are included in the data analysis (r = .420, p = 0.37; see Table 5).

The Anomalous Responding (AR) scale significantly correlated to scores on the antisocial behavior self-report (r = -.488, p = .013; see Table 5). This correlation remained significant even after removing the high AR score cases (r = -.431, p = .045; see Table 6).

Consistency between the HIT scales (including HIT Overall Scale, Overt Scale, Covert Scale, Self-Centered, Blaming Others, Minimizing/Mislabeling, Assuming the Worst, Opposition Defiance, Physical Aggression, Lying, and Stealing) was found to be highly reliable (α = .987). The AR scale negatively correlates with each of the other subscales, in line with expectations as the AR scale measures impression management by the participant (if a participant were trying to give socially desirable answers, they would have lower scores on each of the HIT scales). The Cronbach's alpha for all of the HIT scales when the AR is included in the statistical test is still extremely high (α = .952).

Table 1 presents all of the HIT Scales scores for each of the 26 participants. Higher scores on the Anomalous Responding (AR) Scale indicate greater chance of impression

management by the participant. Higher scores on the rest of the scales (HIT Overall, OV, COV, SC, BO, MM, AW, OD, PA, L, and S) indicate greater agreement with cognitive distortions in each of those categories. The HIT Overall Score is computed by taking the mean of the other eight cognitive distortion scales. The Overt Scale is computed by taking the mean of the Opposition Defiance and Physical Aggression scales. The Covert Scale is computed by taking the mean of the Lying and Stealing scales. The other scales (Self-Centered, Blaming Others, Minimizing/Mislabeling, Assuming the Worst, Opposition Defiance, Physical Aggression, Lying, and Stealing) are computed by taking the questions that correspond to that scale, adding the answers based on the values given in the guidelines, and taking the mean of those answers to get the score for that specific scale.

Table 2 presents the nonclinical, borderline-clinical, and clinical scores for participant's HIT scores. These percentile scores of nonclinical, borderline-clinical, and clinical come from a normative sample of 412 high-school youths who took the HIT. Scores at the 73rd percentile and below are considered nonclinical. Scores from the 74th percentile to the 83rd percentile are considered borderline-clinical. Scores at the 84th percentile and above are considered clinical. Table 3 presents means and standard deviations for each of the HIT scales. Table 4 presents means and standard deviations for each of the HIT scales separated by gender. Table 5 presents the correlations between the AR scale and antisocial behavior, the SC scale and antisocial behavior, and the HIT Overall scale and antisocial behavior. Table 6 presents the same information with the high AR score cases removed.

The Antisocial Behavior scores were calculated in both raw and averaged form. In raw form, the number of responses where a participant indicated "yes" were added together. In average form, the raw score was divided by 16 (or in the case of the participant who left two

antisocial/criminal behavior questions blank, 14; this participant had answered no to the 14 questions, so whether it was divided by 14 or 16 the score was still '0'). One of the 26 participants only completed the HIT questionnaire, so when using the antisocial behavior data in statistical tests $n = 25$ was used, unless the 3 high AR score cases were not being included in the calculated test, making it $n = 22$.

Discussion

We examined TBI patients suffering from substance abuse problems with respect to self-serving cognitive distortions and antisocial behavior. The results indicate that there was a trend, but not a statistically significant correlation, between the HIT overall score and antisocial behavior self-report scores within this small population in this exploratory study. However, the antisocial behavior self-report scores were significantly correlated with the SC scale. The essence of the cognitive distortions, at least for a TBI population, may thus be the self-centered component. If being self-centered is indicated as premier among the distortion factors, it should perhaps become the focus of treatment in an effort to reduce the distorted cognitive thinking that may be supporting antisocial (even criminal) behavior. Another way of thinking about self-centeredness is a lack of perspective taking. If a TBI patient is unable or unwilling to take on the perspective of others, they may not necessarily understand how an antisocial or criminal action against someone else will hurt that person. This lack of perspective taking ability may stem from the TBI itself or it may be a personality trait common to people who are prone to TBIs (e.g., aggressive people who end up in physical fights and as a result sustain a TBI). Self-centeredness, vis-à-vis lack of perspective taking, may be a key in the cognitive distortions of TBI patients.

Perhaps the most surprising finding in this study was that AR scores had a significant correlation with antisocial behavior self-report scores. Although this may have just been an

anomaly due to the small sample size, if further research investigating cognitive distortions within TBI populations replicates this result, it could be interpreted in at least four ways. First, TBI participants who engage more in impression management or answering the HIT in a socially desirable way (i.e., they have higher AR scores) may be engaging in fewer crimes as another type of impression management. Second, TBI participants are susceptible to memory issues, denial issues, and other functional disturbances. It is possible that TBI patients were unable to give accurate responses on the antisocial behavior self-report questions due to memory issues (i.e., they forget the crimes they have committed). Third, low IQ or low educational levels among this TBI population may have also factored into the outcome of the results. Previous research has found that people with a low IQ or low educational level score higher in cognitive distortion use, even if they are from a nondelinquent population (Nas, Brugman, & Koops, 2008). Fourth, it is possible that these participants were accurately reporting on all measures (i.e., they had not engaged in cognitive distortions, common minor indiscretions the AR scale tests for such as gossiping, or criminal behavior). Again, this result may have been an anomaly due to small sample size, the method of administration used with the HIT questionnaire, or another factor. However, it is interesting to consider the various reasons that this result might have appeared in a TBI population.

Based on previous research using the HIT questionnaire, elevations on the Overt Scale may suggest a predilection for antisocial behavior that typically involves confrontation of a victim, whereas elevations on the Covert Scale may suggest a preference for antisocial behavior that is primarily nonconfrontational (Barriga & Gibbs, 1996). Numerous studies have found that these subtypes differ in etiological factors, symptom presentation, and long-term prognosis (Kazin, Kraemer, Kessler, Kupfer, & Offord, 1997). Research has demonstrated direct links

between the Overt versus Covert Scales and overt versus covert behaviors, respectively (Liau, Barriga, & Gibbs, 1998). Within the Overt scale, participants may present with different elevations on the Opposition-Defiance and Physical Aggression subscales. Within the Covert scale, participants may demonstrate different elevations on the Lying and Stealing subscales. This information can be used in treatment and clinical settings for TBI patients because treatment can be altered to focus primarily on the types of behavior that appear most likely. Additionally, being aware of a patient's cognitive tendencies allows clinicians to individualize treatment approaches more effectively (Barriga & Gibbs, 1996). The HIT Questionnaire may also be used in intervention or treatment to evaluate not only a patient's cognitive tendencies but also the success of the program over time.

Many factors could have influenced our results. First is small sample size. Future studies should attempt to include more participants. Second is that this was the first time the HIT had been used in an online format and it was also the first time the HIT had been used with a TBI population. Since there are no other HIT studies using TBI participants, we cannot compare our results as directly to other research. Additionally, using a TBI population in a study focusing on cognition can have drawbacks, as many people with TBI have reduced reading skills, memory problems, and other cognitive difficulties. TBI populations are also prone to paranoia, and many of our participants may have been on parole at the time of their participation, possibly hindering participant's reporting accuracy on the antisocial behavior self-report.

Much of the health field only looks into the physical treatment of TBI. This study is important because it can serve as the basis for paying more attention to the cognitive findings in TBI. When a patient suffers a TBI, many cognitive tests are done to determine how bad their injury was. However, most of the treatment that TBI patients undergo is for physical handicaps.

Interventions and treatment for improving cognition in TBI populations may be lacking because people view cognition as being less malleable than physical or emotional components. Research into the cognitive mechanisms used within TBI samples may help facilitate cognitive behavioral interventions and treatments for this population. Cognition and its many components could be a key in treating TBI and similar injuries and this area should be further researched.

Limitations

The results of this study are limited by numerous factors. Importantly, the small sample size may have limited the statistical power of many of the analyses conducted. Another important limitation is that the study relied solely on self-report measures. The use of self-report measures has been questioned within correctional facilities due to response distortion and reading ability (Edens, Hart, Johnson, Johnson, & Olver, 2000). Although our population was not incarcerated, some of the participants might have been worried about giving truthful answers to the criminal history questions. Additionally, since participants have suffered a TBI, their reading ability, and/or memory, may have been impaired by their injury and hindered their responses. Some of the limitations ascribed to self-report might have been compensated by the fact that the HIT questionnaire includes an Anomalous Responding (AR) scale, which is designed to screen for "disingenuous, incompetent, or other suspect responding" (Wallinius, Johansson, Lardén, & Dernevik, 2011). In future studies, another methodological approach might be preferable. Also in relation to the questionnaire measures, the antisocial behavior self-report scale was not an established measure with proven reliability and validity. Thus, this could have affected our results in unknown ways.

Since this was a clinic-based study, the participants included may not be representative of the entire population of TBI patients in general or TBI patients who abuse substances.

Additionally, according to the Guidelines for scoring the HIT, scores greater than 4.25 on the Anomalous Responding (AR) scale (which indicates attempted impression management by the participant) should be excluded from data analyses in research contexts. However, due to our small sample size and interest in correlating the AR scale with the antisocial behavior data, these participants were not removed for all analyses. This may make the data incompatible with previous and/or future HIT data that follows the guidelines. In addition, the Guidelines note that AR scores greater than 4.00 (but less than or equal to 4.25) should be considered suspect and interpreted cautiously (but not removed). Thus, this diminished our ability to confidently interpret all results.

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Tables

Table 1: How I Think (HIT) Questionnaire Scores

Participant	Anomalous Responding (AR)	HIT (Overall Score)	Overt Scale (OV)	Covert Scale (COV)	Self Centered (SC)	Blaming Others (BO)	Minimizing/ Mislabeling (MM)	Assuming The Worst (AW)	Opposition Defiance (OD)	Physical Aggression (PA)	Lying (L)	Stealing (S)
1	2.50	2.47	2.80	2.90	2.00	2.60	2.11	3.09	3.30	2.30	2.38	2.00
2	2.75	1.57	1.85	1.30	1.67	1.80	1.33	1.45	1.80	1.90	1.50	1.09
3	3.00	2.01	2.20	1.86	1.67	2.40	1.44	2.45	2.10	2.30	2.00	1.73
4	2.75	2.46	2.45	2.53	2.56	2.40	2.00	2.73	2.80	2.10	3.25	1.82
5	3.88	2.23	2.30	2.19	2.33	2.50	1.78	2.27	2.50	2.10	2.38	2.00
6	2.88	2.28	2.40	2.21	1.78	2.60	2.44	2.18	2.40	2.40	2.88	1.55
7	2.50	3.13	3.45	2.85	2.22	3.60	3.33	3.27	3.60	3.30	3.25	2.45
8	4.88	1.25	1.34	1.19	1.11	1.38	1.00	1.45	1.30	1.38	1.38	1.00
9	2.00	3.37	3.85	2.97	3.22	3.70	2.89	3.55	4.20	3.50	3.75	2.18
10	3.12	1.58	1.75	1.40	1.33	2.10	1.44	1.45	2.20	1.30	1.25	1.55
11	2.50	3.34	3.75	2.93	4.00	3.20	3.22	2.91	3.70	3.80	3.50	2.36
12	3.38	1.84	1.90	1.78	1.67	1.70	2.00	2.00	2.00	1.80	2.00	1.56
13	1.75	4.09	4.25	3.96	4.67	3.70	3.56	4.36	4.50	4.00	4.38	3.55
14	3.88	1.42	1.50	1.36	1.56	1.50	1.22	1.36	1.70	1.30	1.62	1.09
15	2.62	2.00	2.35	1.65	2.22	1.90	1.89	2.00	2.70	2.00	1.75	1.55
16	1.75	1.64	1.90	1.40	1.44	1.90	1.22	1.91	2.00	1.80	1.62	1.18
17	4.38	2.18	2.10	2.26	2.00	2.20	2.33	2.18	2.20	2.00	2.25	2.27
18	3.12	3.02	3.10	2.99	2.67	2.90	2.89	3.55	3.50	2.70	3.25	2.73
19	2.88	2.76	3.20	2.33	3.67	2.00	2.44	2.91	3.80	2.60	2.75	1.91
20	4.62	1.95	2.00	1.89	2.00	2.00	1.89	1.91	2.10	1.90	1.88	1.91
21	2.75	2.99	3.05	2.98	2.89	3.30	2.89	2.82	3.60	2.50	3.50	2.45
22	3.62	3.17	3.25	3.12	2.44	3.00	3.22	3.91	3.70	2.80	3.25	3.00
23	3.88	2.30	2.55	2.05	2.33	2.40	2.00	2.45	2.80	2.30	2.00	2.09
24	4.00	1.29	1.40	1.19	1.11	1.10	1.78	1.18	1.30	1.50	1.38	1.00
25	3.00	1.66	1.75	1.59	1.87	2.00	1.56	1.27	2.20	1.30	2.00	1.18
26	1.62	2.79	2.80	2.77	3.67	2.20	2.33	3.00	2.60	3.00	2.62	2.91

Note. Participant's who have data with an AR score greater than 4.00 are to be considered suspect and interpreted cautiously according to the HIT Scoring Guidelines.

Table 2: Nonclinical, Borderline-Clinical, and Clinical percentiles for participant's HIT scores

Participant	Anomalous Responding (AR)	HIT (Overall Score)	Overt Scale (OV)	Covert Scale (COV)	Self Centered (SC)	Blaming Others (BO)	Minimizing/ Mislabeling (MM)	Assuming The Worst (AW)	Opposition Defiance (OD)	Physical Aggression (PA)	Lying (L)	Stealing (S)
1	2.50	56	70	80	<50	64	<50	86	84	54	<50	56
2	2.75	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
3	3.00	<50	<50	<50	<50	54	<50	58	<50	54	<50	<50
4	2.75	54	52	62	60	54	<50	76	68	<50	78	<50
5	3.88	<50	<50	<50	50	62	<50	50	52	<50	<50	56
6	2.88	<50	50	<50	<50	64	62	<50	<50	58	64	<50
7	2.50	86	90	76	<50	92	90	90	92	90	78	76
8	4.88	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
9	2.00	90	96	82	84	92	80	92	98	92	90	66
10	3.12	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
11	2.50	90	94	80	98	84	88	82	92	96	84	74
12	3.38	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
13	1.75	98	98	96	98	92	92	98	98	96	96	94
14	3.88	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
15	2.62	<50	<50	<50	<50	<50	<50	<50	62	<50	<50	<50
16	1.75	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
17	4.38	<50	<50	<50	<50	<50	58	<50	<50	<50	<50	70
18	3.12	82	84	82	66	76	80	92	90	70	78	86
19	2.88	72	86	50	94	<50	62	82	94	66	58	50
20	4.62	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	50
21	2.75	82	82	82	74	86	80	78	92	62	84	76
22	3.62	88	86	86	58	80	88	96	92	74	78	90
23	3.88	<50	58	<50	50	54	<50	58	68	54	<50	62
24	4.00	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
25	3.00	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
26	1.62	74	70	74	94	<50	58	84	58	82	50	90

Notes. Scores are in percentile form. Every HIT Scale except for AR has a percentile score. The percentile scores come from a normative sample of 412 youth who took the HIT. Scores at the 73rd percentile and below are considered nonclinical. Scores from the 74th percentile to the 83rd percentile are considered borderline-clinical. Scores at the 84th percentile and above are considered clinical. Nonclinical scores are colored green and ones below the 50th percentile are noted as "<50". Borderline-clinical scores are colored blue. Clinical scores are colored red.

Table 3: Mean and standard deviation scores for HIT scales

Scale	*M*	*SD*
Anomalous Responding (AR) **(n = 26)**	3.08	0.87
HIT (Overall Score) **(n = 26)**	2.34	0.74
Overt Scale **(n = 26)**	2.51	0.79
Covert Scale **(n = 26)**	2.19	0.72
Self-Centered (SC) **(n = 26)**	2.31	0.91
Blaming Others (BO) **(n = 26)**	2.39	0.71
Minimizing/Mislabeling (MM) **(n = 26)**	2.16	0.72
Assuming The Worst (AW) **(n = 26)**	2.45	0.86
Opposition Defiance (OD) **(n = 26)**	2.72	0.89
Physical Aggression (PA) **(n = 26)**	2.30	0.75
Lying (L) **(n = 26)**	2.45	0.85
Stealing (S) **(n = 26)**	1.93	0.67

Table 4: Gender means and standard deviation scores for HIT scales

	MALES			FEMALES		
Measure	***n***	***M***	***SD***	***n***	***M***	***SD***
AR	17	3.18	0.91	7	2.70	0.78
HIT	17	2.34	0.68	7	2.39	0.88
OV	17	2.55	0.76	7	2.48	0.90
COV	17	2.15	0.65	7	2.33	0.88
SC	17	2.27	0.80	7	2.52	1.20
BO	17	2.43	0.70	7	2.40	0.68
MM	17	2.18	0.73	7	2.08	0.80
AW	17	2.44	0.75	7	2.48	1.05
OD	17	2.79	0.86	7	2.61	0.90
PA	17	2.31	0.71	7	2.34	0.95
L	17	2.38	0.81	7	2.68	0.94
S	17	1.92	0.54	7	1.97	0.91

Notes. AR = Anomalous Responding; HIT = HIT Overall Score; OV = Overt Scale; COV = Covert Scale; SC = Self-Centered; BO = Blaming Others; MM = Minimizing/Mislabeling; AW = Assuming the Worst; OD = Opposition Defiance; PA = Physical Aggression; L = Lying; S = Stealing. A "transgender" option was included but no participants reported being transgender. 2 participants were excluded from this analysis because they did not report gender at all.

Table 5: Pearson correlations for the Anomalous Responding (AR) scale, the Self-Centered (SC) scale, and the HIT Overall scale with the Raw Crime score and the Average Crime score

		Anomalous Responding	Self-Centered	HIT Overall
Raw Crime Score	Pearson Correlation	-.490*	.421*	.324
	Sig. (2-tailed)	.013	.036	.114
	n	25	25	25
Average Crime Score	Pearson Correlation	-.488*	.420*	.324
	Sig. (2-tailed)	.013	.037	.114
	n	25	25	25

Note. Participants with AR scores above 4.25 (considered suspiciously high) were not removed for this analysis.

Table 6: Pearson correlations for the Anomalous Responding (AR) scale, the Self-Centered (SC) scale, and the HIT Overall scale with the Raw Crime score and the Average Crime score

		Anomalous Responding	Self-Centered	HIT Overall
Raw Crime Score	Pearson Correlation	-.433*	.386	.278
	Sig. (2-tailed)	.044	.076	.211
	N	22	22	22
Average Crime Score	Pearson Correlation	-.431*	.385	.277
	Sig. (2-tailed)	.045	.077	.211
	N	22	22	22

Note. Participants with AR scores above 4.25 (considered suspiciously high) were removed for this analysis.

Appendix

The following MATLAB code was used to obtain the HIT scores in Table 1. To run this code, one would need to install MATLAB.

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%% The filename is:   Test2.csv %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
clc
clear
close all

format bank

load Test2.csv
data = Test2;

total = 26; % Number of participants in study. Need to hard code number

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%% Breaks Excel File into participants %%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
for i=1:total
    participants(i,:) = data(i,:);
end

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%% Changes order since data was reveresed %%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

for i = 1:total
    for j = 1:54
        if(participants(i,j) == 1)
            participants(i,j) = 6;
        elseif(participants(i,j) == 2)
            participants(i,j) = 5;
        elseif(participants(i,j) == 3)
            participants(i,j) = 4;
        elseif(participants(i,j) == 4)
            participants(i,j) = 3;
        elseif(participants(i,j) == 5)
            participants(i,j) = 2;
        elseif(participants(i,j) == 6)
            participants(i,j) = 1;
        end
    end
end

for i = 1:total
    for j = 1:87
        d(i,j) = participants(i,j);
    end
end

disp(d)
count = 0;

% Function Variables
[AR] = Anomalous_Responding(d,total,count);
[SC] = Self_Centered(d,total,count,AR);
[BO] = Blaming_Others(d,total,count,AR);
[MM] = Mislabeling(d,total,count,AR);
[AW] = Assuming_The_Worst(d,total,count,AR);
[OD] = Opposition_Defiance(d,total,count,AR);
[PA] = Physical_Aggression(d,total,count,AR);
[L] = Lying(d,total,count,AR);
[S] = Stealing(d,total,count,AR);
```

```
OV = (OD(1,:)+PA(1,:))/2;
COV = (L(1,:) + S(1,:))/2;
Overal_Score = (SC(1,:) + BO(1,:) + MM(1,:) + AW(1,:) + OD(1,:) + ...
    PA(1,:) + L(1,:) + S(1,:))/8;

for i = 1:total
    LastName(i) = i;
end
Participant = LastName(:);
AR = 7-AR';
SC = SC';
BO = BO';
MM = MM';
AW = AW';
OD = OD';
PA = PA';
L = L';
S = S';
OV = (OD(:,1) + PA(:,1))/2;
COV = (L(:,1) + S(:,1))/2;
HIT = (SC(:,1) + BO(:,1) + MM(:,1) + AW(:,1) + OD(:,1) + PA(:,1) + ...
    L(:,1) + S(:,1))/8;


T1 = table(Participant,HIT, AR,OV,COV)
T2 = table(Participant, SC, BO, MM, AW)
T3 = table(Participant, OD, PA, L, S)
%%% NEGLECTING 1,8,17,20

AVG_AR = mean(AR(:,1));
STD_AR = std(AR(:,1));
AVG_SC = mean(SC(:,1));
STD_SC = std(SC(:,1));
AVG_BO = mean(BO(:,1));
STD_BO = std(BO(:,1));
AVG_MM = mean(MM(:,1));
STD_MM = std(MM(:,1));
AVG_AW = mean(AW(:,1));
STD_AW = std(AW(:,1));
AVG_OD = mean(OD(:,1));
STD_OD = std(OD(:,1));
AVG_PA = mean(PA(:,1));
STD_PA = std(PA(:,1));
AVG_L = mean(L(:,1));
STD_L = std(L(:,1));
AVG_S = mean(S(:,1));
STD_S = std(S(:,1));
AVG_OV = mean(OV(:,1));
STD_OV = std(OV(:,1));
AVG_COV = mean(COV(:,1));
STD_COV = std(COV(:,1));
AVG_HIT = mean(HIT(:,1));
STD_HIT = std(HIT(:,1));

Catagory = {'AR', 'SC', 'BO', 'MM', 'AW', 'OD', 'PA', 'L','S', 'OV','COV','HIT'};
AVGs = [AVG_AR, AVG_SC, AVG_BO, AVG_MM, AVG_AW, AVG_OD, AVG_PA, AVG_L, AVG_S, AVG_OV,↙
AVG_COV, AVG_HIT];
STDS = [STD_AR, STD_SC, STD_BO, STD_MM, STD_AW, STD_OD, STD_PA, STD_L, STD_S, STD_OV,↙
STD_COV, STD_HIT];

T4 = table(Catagory', AVGs', STDS')



function [AR] = Anomalous_Responding(d,total,count)
count =0;
for i = 1:total
    for j = 1:87
        participants(i,j) = d(i,j);
    end
end

for i = 1:total
    for j = 1:54
        if((j == 4||j==13||j==20||j==27||j==31||j==38||j==45||j==51) ...
                && participants(i,j) ==-99)
            fprintf('ERROR. -99 score for participant %i for problem %i \n',i,j)
            count = count +1;
            participants(i,j) = 0;
        end
    end

    AR(i) =(participants(i,4)+participants(i,13)...
              +participants(i,20)+participants(i,27) ...
              +participants(i,31)+participants(i,38) ...
              +participants(i,45)+participants(i,51))/(8-count);
end

count = 0;

for i = 1:total
    fprintf('The AR score for participant %0.2d is: ',i)
    disp(AR(i))
end
```

```
function [SC]  = Self_Centered(d,total,count,AR)

count = 0;

for i = 1:total
    for j = 1:87
        participants(i,j) = d(i,j);
    end
end

for i = 1:total
    for j = 1:54
        if((j==3||j==7||j==10||j==22||j==28||j==37||j==42||j==52||j==54) ...
                && participants(i,j) == -99)
            fprintf('ERROR. -99 score for participant %i for problem %i \n',i,j)
            count = count +1;
            participants(i,j) = 0;
        end

    end
    if(AR(i) <= 20)
        SC(i) =(participants(i,3)+participants(i,7)...
              +participants(i,10)+participants(i,22) ...
              +participants(i,28)+participants(i,37) ...
              +participants(i,42)+participants(i,52) ...
              +participants(i,54))/(9-count);
    end

    count = 0;
end
for i = 1:total
    if(SC(i) >= 0)
        fprintf('The SC score for participant %i is: ', i)
        disp(SC(i))
    else
        fprintf('There is no SC score for participant %i because\n', i)
        fprintf('their AR score was above 4.25 \n')
        disp(' ' )
    end
end


function [BO] = Blaming_Others(d,total,count,AR)

count = 0;

for i=1:total
    for j = 1:87
        participants(i,j) = d(i,j);
    end
end

count = 0;
for i = 1:total
    for j = 1:54
        if((j==6||j==11||j==21||j==25||j==26||j==36||j==39||j==44||j==46||j==50) ...
                && participants(i,j) == -99)
            fprintf('ERROR. -99 score for participant %i for problem %i \n',i,j)
            count = count +1;
            participants(i,j) = 0;
        end
    end

    if(AR(i) <= 20.25)
        BO(i) =(participants(i,6)+participants(i,11)...
              +participants(i,21)+participants(i,25) ...
              +participants(i,26)+participants(i,36) ...
              +participants(i,39)+participants(i,44) ...
              +participants(i,46)+participants(i,50))/(10-count);
    end

    count = 0;
end

for i = 1:total
    if(BO(i) >= 0)
        fprintf('The BO score for participant %i is: ', i)
        disp(BO(i))
    else
        fprintf('There is no BO score for participant %i because\n', i)
        fprintf('their AR score was above 4.25 \n')
        disp(' ' )
    end
end
```

```
function [MM] = Mislabeling(d,total,count,AR)

for i = 1:total
    for j = 1:87
        participants(i,j) = d(i,j);
    end
end

count = 0;
for i = 1:total
    for j = 1:54
        if((j ==5||j==12||j==14||j==17||j==19||j==30||j==33||j==40||j==47) ...
                && participants(i,j) == -99)
            fprintf('ERROR. -99 score for participant %i for problem %i \n',i,j)
            count = count +1;
            participants(i,j) = 0;
        end
    end

    if(AR(i) <= 20.25)
        MM(i) =(participants(i,5)+participants(i,12)...
              +participants(i,14)+participants(i,17) ...
              +participants(i,19)+participants(i,30) ...
              +participants(i,33)+participants(i,40) ...
              +participants(i,47))/(9-count);
    end
    count = 0;

end

for i = 1:total
    if(MM(i) >= 0)
        fprintf('The MM score for participant %i is: ', i)
        disp(MM(i))
    else
        fprintf('There is no MM score for participant %i because\n', i)
        fprintf('their AR score was above 4.25 \n')
        disp(' ' )
    end
end


function [AW] = Assuming_The_Worst(d,total,count, AR)

count = 0;

for i = 1:total
    for j = 1:87
        participants(i,j) = d(i,j);
    end
end

for i = 1:total
    for j = 1:54
        if((j == 2||j==8||j==15||j==18||j==23||j==29||j==32||j==35|| ...
                j==43||j==49||j==53) && participants(i,j) == -99)
            fprintf('ERROR. -99 score for participant %i for problem %i \n',i,j)
            count = count +1;
            participants(i,j) = 0;
        end
    end

    if(AR(i) <= 20.25)
        AW(i) =(participants(i,2)+participants(i,8)...
              +participants(i,15)+participants(i,18) ...
              +participants(i,23)+participants(i,29) ...
              +participants(i,32)+participants(i,35) ...
              +participants(i,43)+participants(i,49) ...
              +participants(i,53))/(11-count);
    end
    count = 0;
end


for i = 1:total
    if(AW(i) >= 0)
        fprintf('The AW score for participant %i is: ', i)
        disp(AW(i))
    else
        fprintf('There is no MM score for participant %i because\n', i)
        fprintf('their AR score was above 4.25 \n')
        disp(' ' )
    end
end
```

```
function [OD] = Opposition_Defiance(d,total,count,AR)

for i = 1:total
    for j = 1:87
        participants(i,j) = d(i,j);
    end
end
count = 0;
for i = 1:total
    for j = 1:54
        if(( j==2||j==6||j==12||j==18||j==29||j==37||j==40||j==42||j==46||j==54) ...
                && participants(i,j) == -99)
            fprintf('ERROR. -99 score for participant %i for problem %i \n',i,j)
            count = count +1;
            participants(i,j) = 0;
        end
    end

    if(AR(i) <= 20.25)
        OD(i) =(participants(i,2)+participants(i,6)...
              +participants(i,12)+participants(i,18) ...
              +participants(i,29)+participants(i,37) ...
              +participants(i,40)+participants(i,42) ...
              +participants(i,46)+participants(i,54)) ...
              /(10-count);
    end
        count = 0;
end


for i = 1:total
    if(OD(i) >= 0)
        fprintf('The OD score for participant %i is: ', i)
        disp(OD(i))
    else
        fprintf('There is no OD score for participant %i because\n', i)
        fprintf('their AR score was above 4.25 \n')
        disp(' ' )
    end
end


function [PA] = Physical_Aggression(d,total,count,AR)
count = 0;
for i = 1:total
    for j = 1:87
        participants(i,j) = d(i,j);
    end
end
count = 0;
for i = 1:total
    for j = 1:54
        if((j==5||j==10||j==15||j==19||j==23||j==28||j==32||j==36||j==44||j==50) ...
                && participants(i,j) == -99)
            fprintf('ERROR. -99 score for participant %i for problem %i \n',i,j)
            count = count +1;
            participants(i,j) = 0;
        end
    end

    if(AR(i) <= 20.25)
        PA(i) =(participants(i,5)+participants(i,10)...
              +participants(i,15)+participants(i,19) ...
              +participants(i,23)+participants(i,28) ...
              +participants(i,32)+participants(i,36) ...
              +participants(i,44)+participants(i,50)) ...
              /(10-count);
    end
        count = 0;
end


for i = 1:total
    if(PA(i) >= 0)
        fprintf('The PA score for participant %i is: ', i)
        disp(PA(i))
    else
        fprintf('There is no PA score for participant %i because\n', i)
        fprintf('their AR score was above 4.25 \n')
        disp(' ' )
    end
end
```

```
function [L] = Lying(d,total,count,AR)

for i = 1:total
    for j = 1:87
        participants(i,j) = d(i,j);
    end
end
count = 0;
for i = 1:total
    for j = 1:54
        if((j==3||j==8||j==14||j==21||j==26||j==33||j==49||j==52) ...
                && participants(i,j) == -99)
            fprintf('ERROR. -99 score for participant %i for problem %i \n',i,j)
            count = count +1;
            participants(i,j) = 0;
        end
    end

    if(AR(i) <= 20.25)
        L(i) =(participants(i,3)+participants(i,8)...
              +participants(i,14)+participants(i,21) ...
              +participants(i,26)+participants(i,33) ...
              +participants(i,49)+participants(i,52)) ...
              /(8-count);
    end
        count = 0;
end


for i = 1:total
    if(L(i) >= 0)
        fprintf('The L score for participant %i is: ', i)
        disp(L(i))
    else
        fprintf('There is no L score for participant %i because\n', i)
        fprintf('their AR score was above 4.25 \n')
        disp(' ' )
    end
end


function [S] = Stealing(d,total,count, AR)
count =0;
for i = 1:total
    for j = 1:87
        participants(i,j) = d(i,j);
    end
end


for i = 1:total
    for j = 1:54
        if((j ==7|| j == 11|| j== 17||j ==22||j ==25||j== 30 ...
                ||j==35||j==39||j==43||j==47||j==53) ...
                && participants(i,j) == -99)
            count = count+1;
            participants(i,j) = 0;
        end
    end

    if(AR(i) <= 20.25)
        S(i) =(participants(i,7)+participants(i,11)...
              +participants(i,17)+participants(i,22) ...
              +participants(i,25)+participants(i,30) ...
              +participants(i,35)+participants(i,39) ...
              +participants(i,43)+participants(i,47) ...
              +participants(i,53))/(11-count);
    end
    count =0;
end


for i = 1:total
    if(S(i) >= 0)
        fprintf('The S score for participant %i is: ', i)
        disp(S(i))
    else
        fprintf('There is no S score for participant %i because\n', i)
        fprintf('their AR score was above 4.25 \n')
        disp(' ' )
    end
end
```